## REMARKS

Applicant submits herewith the Declarations of Gary A. Cooke and Alan M. Levine in connection with this response.

The Office Action again states that the oath or declaration is defective because it does not identify the address of each inventor. Applicant respectfully submits that the declaration and application data sheet previously submitted contain this information and are in accordance with applicable rules. Applicant would like to direct the Examiner's attention to 37 CFR 1.63(a)(2), which states that a declaration must identify each inventor by name and (a)(3) include the country of citizenship of each inventor. Notably, 1.63(a)(3) does not require the city of residence of the inventor. 1.63 further specifies in subpart (c) that "unless such information is provided in an application data sheet in accordance with 1.76", the declaration must include the mailing address of each inventor. Therefore, the declaration need not include the mailing address if this information is provided in the application data sheet. As an application data sheet containing the mailing address of each inventor was submitted with this application, the declaration is not defective. Applicant requests withdrawal of this objection.

### Rejections Under 35 USC § 103

The Office Action notes that this application currently names joint inventors. Applicant submits herewith copies of Assignments indicating that both the present application and the continuation-in-part application, 09/925,391, have been assigned to RJLee Group, Inc., and the inventions were commonly owned at the time of invention.

Claims 1-26 were again rejected under 35 USC § 103(a) as being unpatentable over Gi (4,463,203) in view of either Roy (4,740,270) or Solbakken et al. (4,250,158) when considered with prior art said to be admitted by applicants. Applicant respectfully traverses this rejection.

The Examiner picks and chooses among references, using hindsight, to arrive at the present invention. For example, Gi is cited for allegedly disclosing a pyrolysis process which uses bentonite, and which is said to contain metals such as magnesium and aluminum. Applicants respectfully submit that none of the cited references teach the use of metal dust in combination with clay, in a vacuum pyrolysis method, to provide an improved carbonaceaous product produced with lower energy input.

As described in the accompanying declaration of Gary A. Cooke, the metals found in bentonite are not free, and are bound up in the clay in the form of $Al_2O_3$ and MgO.

As can be seen in the chemical formula, the metals in clay are in the oxidized state. The oxidized metals found in clay do not function in a similar manner as free metals in the elemental state, and they cannot possibly provide the same chemistry in the pyrolysis reaction.

As described in the Cooke declaration at item 9 (iii), the specific purpose of the addition of metals in the zero valence state is to provide a reagent that reacts with the organic material during pyrolysis in a manner that increases the yield of desirable hydrocarbons. When oxygen is removed by the oxidation of the metals, hydrogen gas is created. The hydrogen gas serves as a fuel, and is capable of hydrocracking the larger hydrocarbons released by the pyrolysis process, thus producing the desirable lighter hydrocarbons. Metals which are already oxidized, e.g. those found in clay, are not able to undergo this reaction. Thus, Gi does not explicitly or inherently disclose the metals used in the present invention.

Further, Gi does not, as asserted by the Examiner, teach the amounts of clay and metal dust, or the mesh size of the metal particles used in the present invention. As recited in Claim 7, the clay-metal dust catalyst is present in an amount of about 0.01 wt.% to 3.0 wt.%, based on the weight of the hydrocarbon material. The specification states at page 7 that the catalyst contains metals and clay in the following proportions: [0.1 - 2 parts] Al : [0.1 - 2 parts] Mg : 8 parts clay. This translates into 0.00012 – 0.00167 wt.% Al or Mg at the lower end of the range, and 0.036 - 0.501 wt.% at the high end of the range. Claim 12 recites a mesh size of 200 for the aluminum particles, and a mesh size of 325 for magnesium. These amounts and particles sizes are not taught or suggested in Gi, nor any other reference cited by the Examiner or known to Applicant. Thus, Claims 7-12 in particular are not obvious in view of the cited references.

The present invention provides unique benefits, in that less energy is used in the pyrolysis method, and yet a high grade of carbon black is produced, with minimal unpyrolyzed material. As can be seen in the data presented in the declaration of Alan M. Levine, use of metal dust in combination with clay as a catalyst results in an improved carbon black product, as can be seen in Figures 2a and 2b, which show scanning electron micrographs of non-catalyzed pyrolyzed carbon black (2a), and pyrolyzed carbon black when bentonite/metals is used as a catalyst (2b). The catalyzed process results in a carbon black having far fewer pock marks and denotes a higher quality product. Figures 3a-3c show the differences in residue on the carbon black particles in catalyzed (3b) and non-catalyzed (3a)

pyrolysis reactions. Less residue is indicative of a higher quality product. Figures 4a-4c also show this difference in residue, using transmission electron microscope images. Figure 5 shows that less oil and less pitch-like polymeric material is present in the carbon black product from the catalyzed process. Finally, Figure 6 shows a sieve analysis of the carbon black product from both catalyzed and non-catalyzed reactions. More of the carbon black product from the catalyzed reaction was able to fit through the sieve, indicating less polymer in the carbon black.

In addition, the catalyzed reaction progresses at a higher temperature, even when heat is removed during the reaction (Figure 1), and less energy is required to maintain the reaction temperature (Figure 7) when a catalyst is used. Figure 7 also demonstrates the benefits of having a zoned reactor, because the reaction proceeds at different rates and temperatures over the course of the pyrolysis process. None of the cited references teach that the reaction progresses in such a manner, and none indicate the usefulness of zoned energy input.

These results could not have been predicted by one skilled in the art, based on the teachings of the cited references, or any based on any references known to Applicant.

As previously noted, Gi uses much higher temperatures than Applicant's: at column 1, line 14, a pyrolysis temperature range of 600-700 °C is disclosed, which converts to 1112 -1292°F. The example shows use of even higher temperatures, 700-800°C (col. 4, line 55). There is no suggestion in Gi that temperatures can be <u>lowered</u>, to arrive at an improved product. Nevertheless, the Examiner has combined Gi with Solbakken or Roy, said to disclose similar processes under low pressure, to arrive at the present invention. Applicant respectfully disagree with the Examiner's characterization of these references.

Roy is cited for teaching a low pressure pyrolysis process, but the "sub-atmospheric pressure" used in Roy is insignificant (< 35mm Hg, which converts to < 1.38 in. Hg), in comparison with the low pressure used in the present invention (2-16 in. Hg). There is no suggestion in Roy that a lower pressure in combination with the temperatures disclosed will result in an improved carbonaceous product. Moreover, at column 1, lines 65- 68, and as pointed out by the Examiner in the present office action at page 3, 4th paragraph, Roy discloses that under sub-atmospheric pressure, *the yield of the highly desired <u>liquid</u> hydrocarbons is significantly <u>increased</u>, while the yields of the less desired gaseous hydrocarbons <u>and solid carbonaceous material are lowered</u>* (emphasis added). One skilled in the art would obtain no guidance whatsoever on how to improve the solid products of

pyrolysis, as these are disclosed as undesirable. In fact, Roy can be said to teach away from the present invention. According to the MPEP at 2145, it is improper to combine references where the reference or references teach away from the combination. Therefore, the Roy reference cannot be combined with Gi to arrive at the present invention.

Solbakken is also cited for teaching a low pressure pyrolysis process. However, Solbakken does not teach the use of a catalyst, and uses much higher temperatures than those used in the present invention: 750°-1800°F, as compared with 450°-850° in the present invention. Solbakken does not disclose that use of a low pressure system in combination with the temperatures used in the present invention would provide complete pyrolysis and an improved carbon black product. One skilled in the art would find no guidance in Solbakken on how to use temperatures lower than those disclosed, and yet achieve an improved carbon black product. Generally, one assumes that lowering temperatures in pyrolysis will result in incomplete pyrolysis of the hydrocarbon material, and in the absence of specific guidance one skilled in the art would not expect that lower temperatures would suffice.

The process of Solbakken shows other differences from the method of the present invention. Solbakken heats the waste material to loosen fibers and then separates the pieces before complete pyrolyzation. In any event, Solbakken does not teach the use of any catalyst at all, and so cannot provide the missing teaching.

As presently reflected in Claims 15-20, the present invention involves a method of pyrolysis in which the heating of the hydrocarbon material occurs in at least three phases. During each phase, affirmative steps are taken to adjust the fuel input and minimize the energy used, while maintaining the pyrolysis reaction and driving it to completion. As previously pointed out, Figure 3 in the specification shows two heat sources at each end of the reactor chamber (more can be used). These heat sources can be adjusted independently, to provide minimal fuel input when, during the course of the reaction, less is needed. In a batch process, the fuel input can be adjusted over time (by microprocessor, for example), to take advantage of the energy of the reaction.

None of the cited references teach or suggest this aspect of the invention. Again, Applicants disagree with the Examiner's characterization of the Gi reference. The text in Gi asserted by the Examiner to show heating in different phases (column 2, lines 30-51), does not teach the use of different heating phases at all, but merely describes at what temperature the various reactions will occur. The language used indicates that passive

observations were made of the reaction process. For example, "the adhered moisture, $CO_2$, and $CH_4$ on the brown coal *was radiated off* in the range of temperature 100° - 200°......"; "Gas, water and tar *was rapidly released* ...."; "after exceeding the temperature of 500°, the production of tar *is hardly present*." There is absolutely no indication that affirmative steps were taken to adjust the fuel input, as in the present invention. Other than the Examiner's bald assertion that one skilled in the art would be motivated to adjust the fuel input, there is no basis for concluding that this step is taught or suggested anywhere in the prior art. Roy and Solbakken do not teach this aspect of the invention either, and therefore cannot provide the missing teaching. Applicants submit that Claims 15-20, in particular, are not obvious in view of the Gi reference alone, or in combination with the other references.

Applicants respectfully submit that none of the cited references disclose or suggest the a pyrolysis method in which clay is used in combination with a metal dust as a catalyst, and heating occurs in at least three phases. Therefore, these references simply cannot be combined to provide the missing teachings.

Claim 27 was rejected under 35 USC § 103(a) as being unpatentable over Gi (4,463,203) in view of either Roy (4,740,270) or Solbakken et al. (4,250,158) in view of Cha et al. (4,983,278). Cha is said to teach the use of tar sands. However, Cha does not provide the other missing teachings, namely use of a metal dust in combination with clay as a catalyst, nor heating in different phases. Applicants submit that Claim 27 is not obvious in view of the cited references and requests withdrawal of this basis of rejection.

## SUMMARY

As all outstanding issues have been addressed, Applicants submit that Claims 1-27 are in condition for allowance; such action is respectfully requested at an early date.

**Respectfully submitted,**

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